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Mapping pedagogical strategies for education for sustainable development in higher education: A systematic review of reported relationships with students' competencies

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 25 August 2026 and was last updated on 25 August 2026.

INTRODUCTION

Review question / Objective This systematic review asks: What pedagogical strategies are used for education for sustainable development (ESD) in higher education, and how are these strategies reported to relate to students' competencies for sustainable development? Using a PICOS structure: the population is higher education students; the intervention is ESD-related pedagogical strategies, teaching methods, instructional interventions, or learning activities; comparators are not required, although comparative and non-comparative empirical studies are eligible; outcomes are reported sustainability-related competencies or competency-oriented learning outcomes; and eligible study designs are empirical qualitative, quantitative, and mixed-methods studies.

Rationale Higher education institutions are expected to prepare students to address complex sustainability challenges, yet the pedagogical relationship between ESD teaching strategies and students' sustainability competencies remains insufficiently clarified. Existing competency frameworks identify important learning outcomes, but educators often lack clear evidence about which pedagogical designs are associated with which competencies. This review addresses that gap by systematically mapping empirical studies of ESD pedagogy in higher education and synthesising reported links between teaching approaches and competency development.

Condition being studied The phenomenon under review is education for sustainable development in higher education, specifically formal teaching and learning activities designed to develop students' sustainability-related competencies. These competencies include systems thinking, anticipatory, normative, strategic, collaboration, critical thinking, self-awareness, and integrated problem-solving competencies.

METHODS

Search strategy The search was conducted in Web of Science and Scopus. The Boolean search strategy combined three groups of terms: ("education for sustainable development" OR "sustainable development education" OR "sustainability education") AND ("higher education" OR university OR college OR "tertiary education" OR undergraduate OR graduate) AND ("pedagogical approaches" OR "instructional strategies" OR "teaching strategies" OR "teaching methods" OR "instructional approaches"). Searches were restricted to English-language peer-reviewed journal articles published between 2010 and 2025.

Participant or population Students enrolled in tertiary or higher education, including university, college, undergraduate, and graduate students participating in formal ESD or sustainability-related learning contexts.

Intervention Pedagogical approaches, teaching methods, instructional interventions, or learning activities designed to support sustainability-related learning in higher education. Examples include project-based learning, problem-based learning, service learning, role play, simulation, debate, flipped learning, collaborative learning, and other ESD-oriented pedagogical designs.

Comparator No specific comparator is required. Eligible studies may include single-group, case-based, qualitative, quantitative, mixed-methods, or comparative designs. Where present, comparators may include conventional teaching, alternative pedagogical approaches, or pre-intervention baseline measures.

Study designs to be included Empirical qualitative, quantitative, and mixed-methods studies, including intervention evaluations, case studies, quasi-experimental studies, surveys, interviews, focus groups, document analysis, artefact analysis, and other empirical studies of ESD pedagogy.

Eligibility criteria Included studies must be full-text accessible, peer-reviewed journal articles published in English between 2010 and 2025; focus on students in tertiary or higher education; be conducted in formal higher education teaching and learning contexts; report pedagogical approaches, teaching methods, instructional interventions, or learning activities for sustainability-related learning; use empirical qualitative, quantitative, or mixed-methods data; and report students' sustainability-related competencies, competency development, or ESD-related learning outcomes. Excluded studies include non-peer-reviewed publications, non-English publications, studies outside higher education, K-12 or non-student populations, non-formal learning contexts, studies without pedagogical focus, theoretical/review/opinion papers without empirical data, and studies not addressing sustainability-related student competencies.

Information sources Electronic database searches were conducted in Web of Science and Scopus. The review focused on peer-reviewed journal articles. Grey literature, trial registers, author contact, and non-journal sources were not included.

Main outcome(s) The main outcomes are reported relationships between ESD pedagogical strategies and students' sustainability-related competencies. Competencies are coded using UNESCO's framework: systems thinking, anticipatory, normative, strategic, collaboration, critical thinking, self-awareness, and integrated problem-solving. No common effect measure is required because the review uses narrative and thematic synthesis rather than meta-analysis.

Additional outcome(s) Additional outcomes include the types of pedagogical strategies used in ESD higher education, teaching-model family combinations, geographical distribution of studies, study design characteristics, sample-size patterns, evidence/measurement types, and enabling conditions for competency-oriented ESD pedagogy.

Data management Records were retrieved from Web of Science and Scopus, deduplicated, and screened by title, abstract, and full text using predefined inclusion and exclusion criteria. Data from eligible studies were extracted into a structured coding framework covering study characteristics, research design, pedagogical design, teaching-model family, competency dimensions, and evidence/measurement type. Coding was conducted independently by two raters, inter-rater reliability was assessed using Cohen's kappa, and disagreements were resolved through discussion.

Quality assessment / Risk of bias analysis The manuscript does not report a formal risk-of-bias tool. Quality control was addressed through inclusion of peer-reviewed full-text empirical studies, structured eligibility criteria, extraction of

methodological characteristics, duplicate independent coding, Cohen's kappa assessment of inter-rater agreement (κ = 0.95), and consensus resolution of disagreements. Evidence quality and comparability are considered narratively rather than through exclusion based on risk-of-bias scores.

Strategy of data synthesis The review uses thematic synthesis. First, deductive coding is guided by two frameworks: UNESCO's competencies for sustainable development and Joyce et al.'s four families of teaching models. Second, inductive coding is used to identify emergent or hybrid pedagogical patterns not fully captured by the predefined frameworks. Findings are synthesised narratively to map relationships between pedagogical strategies and reported competency profiles. Meta-analysis is not planned because studies differ substantially in design, context, interventions, measurement methods, and outcomes.

Subgroup analysis No formal statistical subgroup analysis is planned. Descriptive comparisons will be made by pedagogical strategy, teaching-model family, competency dimension, geographical region, sample-size category, and methodological approach.

Sensitivity analysis No quantitative sensitivity analysis is planned because no meta-analysis is conducted. Robustness will be considered narratively by examining whether identified pedagogical patterns remain visible across study designs, regions, sample-size categories, and evidence/measurement types.

Language restriction Yes. Only English-language peer-reviewed journal articles were included.

Country(ies) involved China; authors are affiliated with Shanghai Jiao Tong University, China.

Other relevant information This is a non-clinical educational systematic review. The review follows PRISMA reporting principles and includes a PRISMA flow diagram. The final review included 33 empirical studies published between 2010 and 2025. No new primary data involving human participants were collected for this review.

Keywords Education for sustainable development; higher education; pedagogical strategies; sustainability competencies; systematic review; teaching models; pedagogical design.

Contributions of each author

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